# How Paired is Paired?

Comparing Nitrate Concentrations in Three Iowa Drainage Districts.
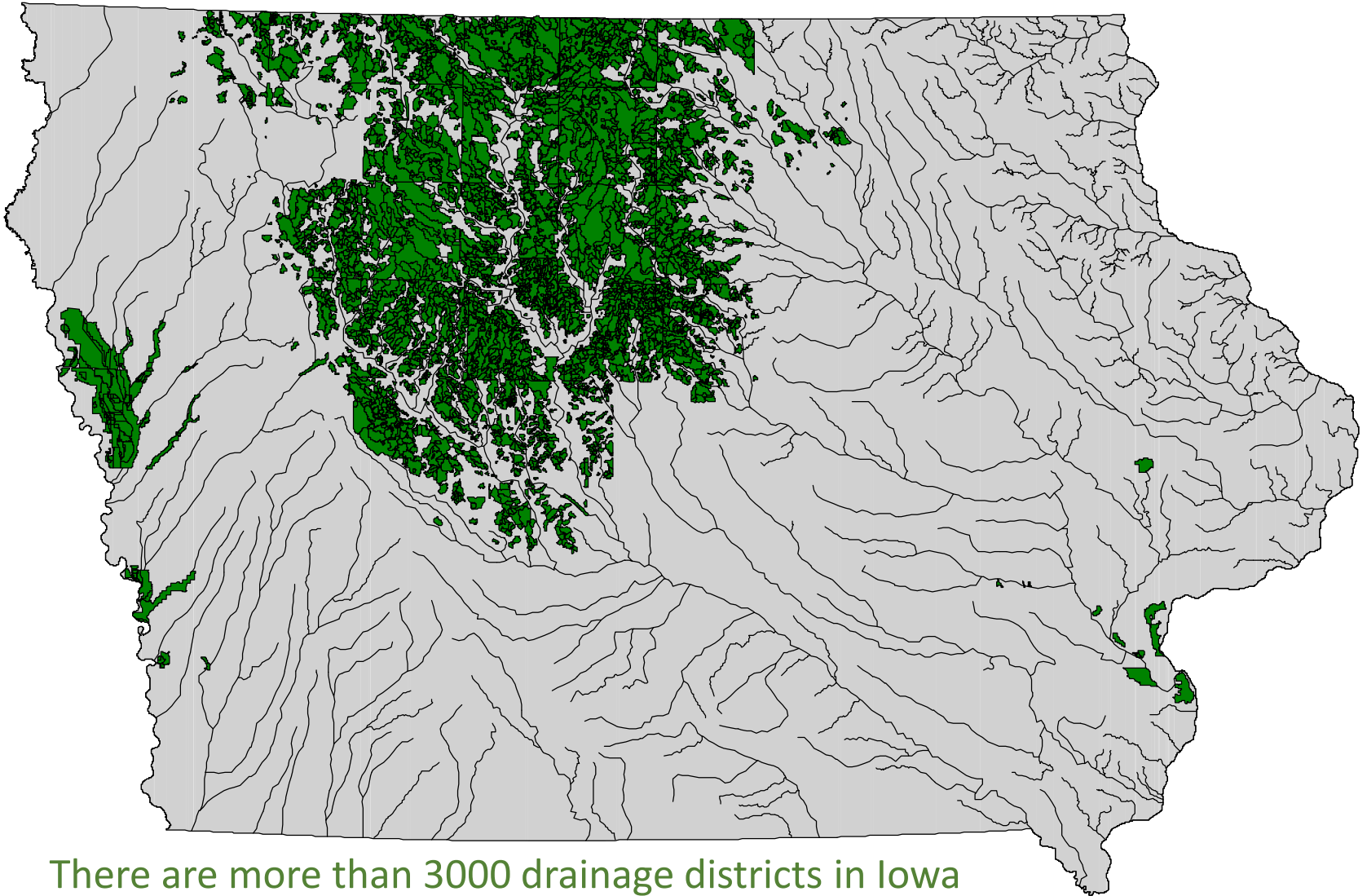
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Iowa Soybean Association

# Iowa Soybean Association
## Environmental Programs and Services

- *Advance <u>agricultural leadership</u> for environmental quality by <u>developing, applying, and promoting programs that </u>assist producers to <u>perform</u> agronomically and economically*

- Develops policies and programs that help farmers expand profit opportunities while promoting environmentally sensitive production using the soybean checkoff and other resources.

- The Association is governed by an elected volunteer board of 21 farmers.

- Largest State-based row crop commodity association in U.S. serving 45,000 Iowa soybean farmers.

**IOWA SOYBEAN** *Association*
Expanding Opportunities. Delivering Results.

*Advancing Agricultural Performance*®

**Environmental Programs & Services**
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# Subsurface Drainage

There are more than 3000 drainage districts in Iowa

- 42 km² watershed in



State of Iowa
Des Moines Lobe

LCR5T
LCR4T
LCR3T

Webster City

Drainage district tiles
Drainage district area
Lyons Creek watershed
Rivers and streams

0  1  2        4 Kilometers

Objective: Establish a paired watershed study using the three drainage districts
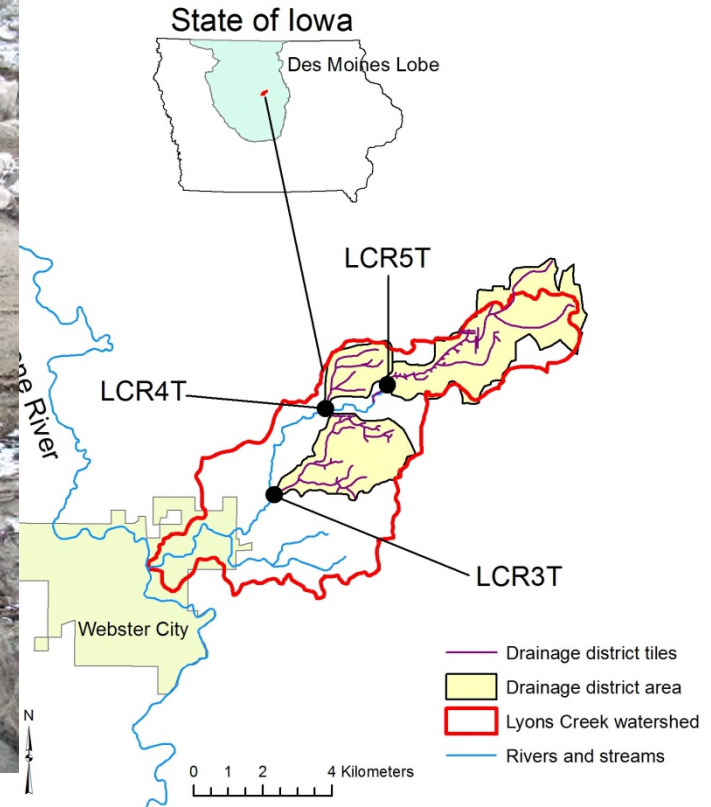
# Basin Properties

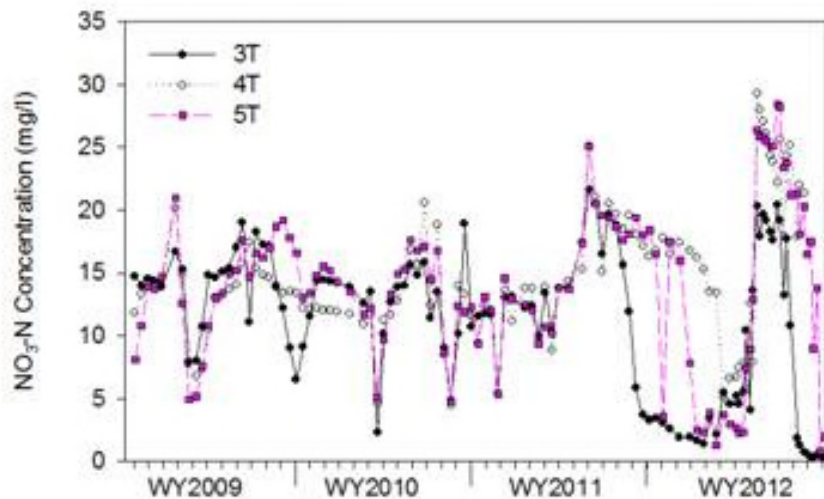| Property | LCR3T | LCR4T | LCR5T |
|---|---|---|---|
| Slope (%) | $4.05 \pm 2.98$ | $4.18 \pm 3.04$ | $4.24 \pm 3.11$ |
| Slope range (%) | 0-91.5 | 0-89.9 | 0-79.7 |
| Depressional areas (% of basin with DEM fill) | 3.65 | 5.51 | 7.67 |
| Major Soil Types (% of basin): | | | |
|    Boden | 21.08 | 21.53 | 19.45 |
|    Ottosen | 24.94 | 16.57 | 16.13 |
|    Storden | 0.42 | 1.08 | 0.10 |
|    Kossuth | 28.49 | 39.47 | 42.84 |
|    Brown | 22.87 | 4.67 | 9.23 |
|    Harps | 0.09 | 6.40 | 5.46 |
|    Okoboji | 1.46 | 9.74 | 6.31 |
| | | | |
| Average Soil Texture (%): | | | |
|    Sand | 21.9 | 19.9 | 19.4 |
|    Silt | 40.9 | 44.6 | 44.6 |
|    Clay | 37.2 | 35.5 | 36.0 |
| Organic matter (%) | 5.62 | 5.89 | 5.85 |
| | | | |
| Soils needing tile drainage to farm[†] (% of basin) | 77.6 | 77.4 | 80.0 |
| Land receiving manure application[‡] (% of basin) | 89.2 | 0.8 | 51.2 |
| | | | |
| Row crop land cover (% of basin) | 93.1 | 92.1 | 90.4 |
| Mulch tillage (% of row crop land) | 88.2 | 89.3 | 98.1 |

# Water Monitoring 2009-2012

- Grab samples collected every two weeks at drainage district outlets and analyzed for nitrate-nitrogen ($NO_3$-N)

- Climate variability during the monitoring period
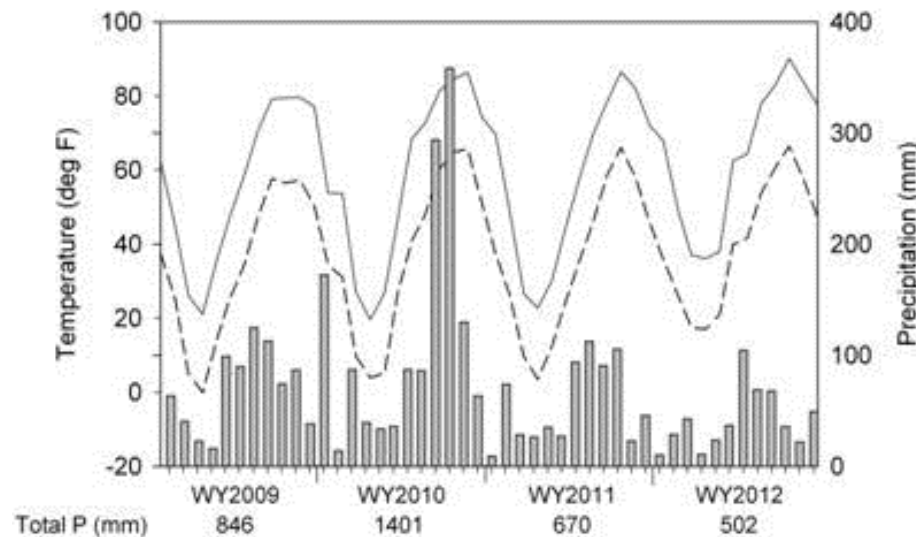
# NO$_3$-N Concentrations
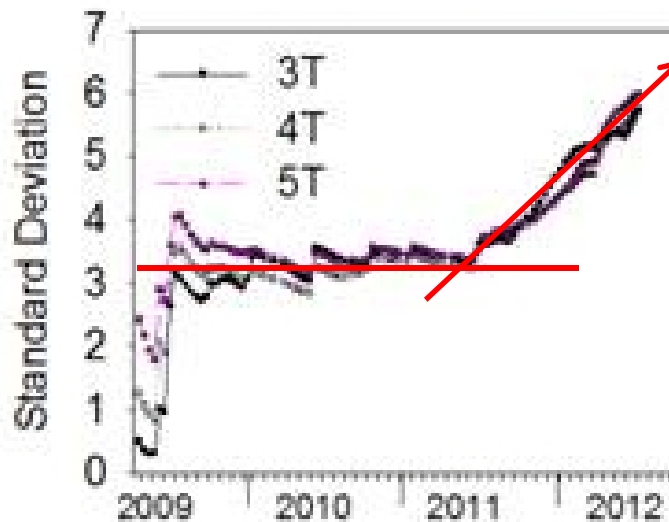


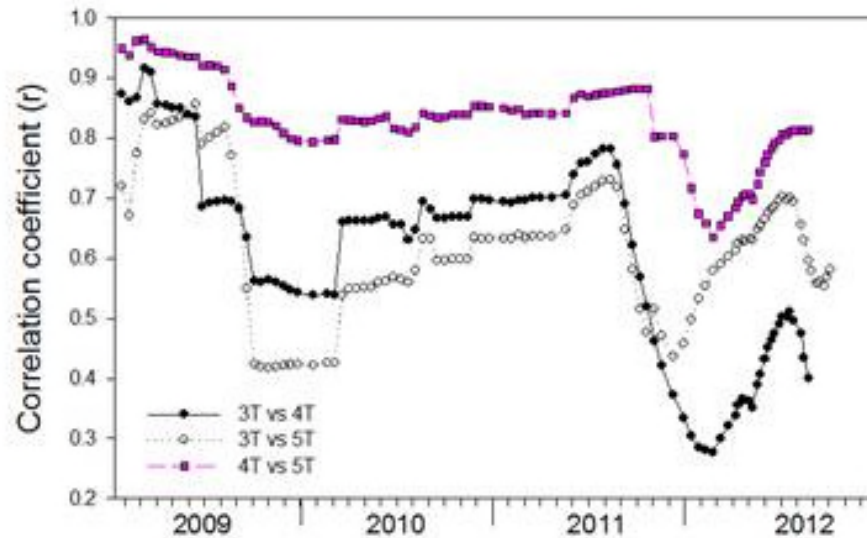| Statistics | LCR-3T | LCR-4T | LCR-5T |
|---|---|---|---|
| mean | 11.1 | 14.7 | 14.0 |
| min | 0.0 | 4.4 | 0.8 |
| max | 21.6 | 29.3 | 28.4 |
| March-July period | | | |
| mean | 14.1 | 15.7 | 15.7 |
| min | 2.3 | 4.6 | 2.3 |
| max | 21.6 | 29.3 | 28.4 |

## Intrinsic variability



Standard deviation increased with additional samples collected in 2011 and 2012

# How Paired is Paired?

Cumulative correlation
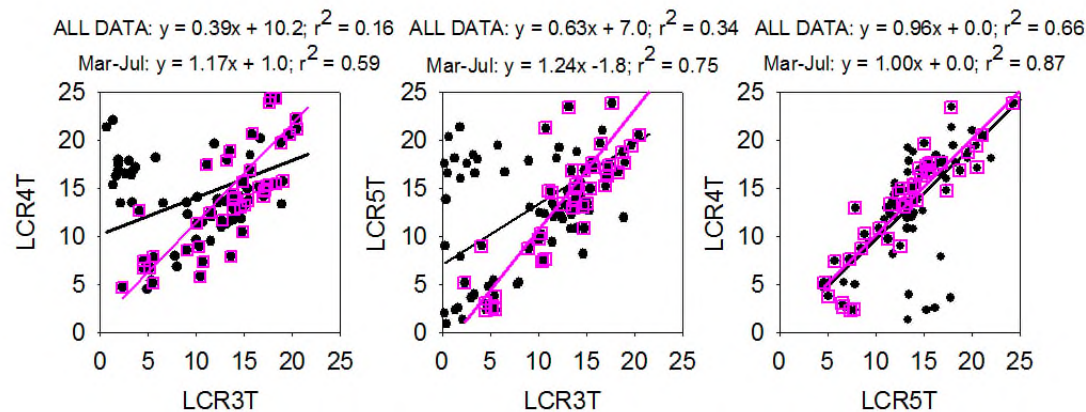


|  | 3T-4T | 3T-5T | 4T-5T |
|---|---|---|---|
| Total period | 0.399 | 0.597 | 0.814 |
| Mar-Jul | 0.769 | 0.865 | 0.934 |

## Linear regression



ALL DATA: y = 0.39x + 10.2; $r^2$ = 0.16    ALL DATA: y = 0.63x + 7.0; $r^2$ = 0.34    ALL DATA: y = 0.96x + 0.0; $r^2$ = 0.66

Mar-Jul: y = 1.17x + 1.0; $r^2$ = 0.59    Mar-Jul: y = 1.24x -1.8; $r^2$ = 0.75    Mar-Jul: y = 1.00x + 0.0; $r^2$ = 0.87

Relation between sample pairs was improved during March to July period

# MDC in NO$_3$-N Concentrations

High MDC = many years to detect 10% change

| Control | Treatment | n | MDC (%) | # of samples needed to see 10% change | # of years to monitor (26 samples/yr) | | n | MDC (%) | # of samples needed to see 10% change | # of years to monitor (13 samples/yr) |
|---------|-----------|-----|------|-----|------|-----------|----|------|-----|------|
| LCR3T | LCR4T | 103 | 11.8 | 224 | 8.6 | NO$_3$-N | 50 | 12.4 | 150 | 11.5 |
| LCR3T | LCR5T | 109 | 12.9 | 474 | 18.2 | (subset) | 50 | 10.5 | 61 | 4.7 |
| LCR4T | LCR5T | 103 | 7.0 | 35 | 1.3 | | 50 | 6.7 | 16 | 1.2 |
| LCR4T | LCR3T | 103 | 9.6 | 90 | 3.5 | | 50 | 8.3 | 28 | 2.1 |
| LCR5T | LCR3T | 109 | 8.7 | 67 | 2.6 | | 50 | 6.5 | 15 | 1.2 |
| LCR5T | LCR4T | 103 | 6.9 | 25 | 1.0 | | 50 | 6.2 | 13 | 1.0 |

Lowest MDC value

MDC values are lower with fewer samples if Mar-Jul period used

# How Paired is Paired?

- Lack of correlation affects the ability to detect changes

Correlation of 0.4 =
MDC of 11.8%

Correlation of 0.81 =
MDC of 6.9%